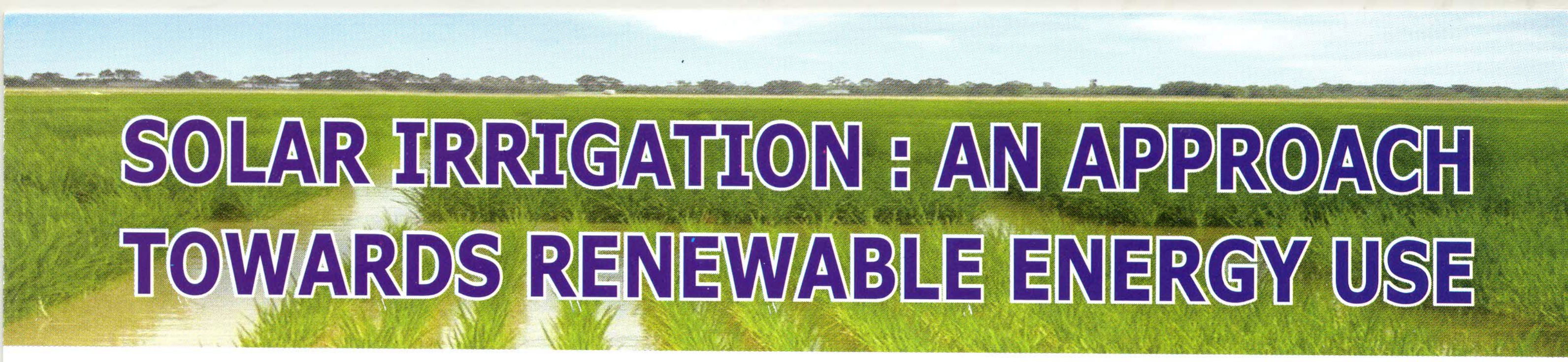

SOLAR IRRIGATION : AN APPROACH TOWARDS RENEWABLE ENERGY USE

Bangladesh has major problems of energy crisis, persisting poverty and environmental degradation. Ever increasing fuel cost and doubtful availability of electricity hampers the irrigation for crop production. There are about 1.76 million irrigation pumps in Bangladesh among them 85% are diesel operated. The price of diesel is hiking every year has risen locally about 33% in 2011. The demand of electricity in irrigation is growing since the cost of electric power driven pump is lower compared to the diesel driven pump. Solar pump may be an alternative for small scale irrigation for crop production in the off-grid area of Bangladesh. Solar pump is a pollution free and environment friendly water pumping system in agriculture.

Being a tropical country, Bangladesh is endowed with abandoned supply of solar energy. The ranges of solar radiation are between 4 and 6.5 kWh/m^2/day and the bright sunshine hours vary from 6 to 9 hours/day. At present photovoltaic (PV) cell is expensive which is the main reason for its low acceptance. But with the advancement of technology, its price has been decreasing remarkably. In Bangladesh about 59% land is under irrigation. There is a vast area need to be irrigated where there is no grid connection. Solar PV pump may be used for irrigating this land for better crop production. This note gives the present scenario of solar pump irrigation system in Bangladesh along with its technical economic feasibility.

Approach and Methodology

Information and data were generated by Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute (BARI), Gazipur with the financial assistance of Bangladesh Agricultural Research Council (BARC), Dhaka under the SPGR subproject 'Development and adaptation of solar pump irrigation system under eco-friendly environment' during the period of 2010-2012.

A base-line survey was conducted on the present status of solar pump in Bangladesh. Primary information was collected from solar pump traders, service providers and users through direct interviewing. Secondary information was collected from relevant reports, journals, internet etc.

Five solar pumps, two were locally designed and three were made by USA, Australia and China were tested to select the suitable solar pump for irrigation. BARI designed solar pump was made with 800 W dc motor coupled with 0.5 hp locally made centrifugal pump. Dhaka University (DU) designed solar pump was made with ac motor, 0.5 hp centrifugal pump, inverter (1000 W), charge controller and battery (24 V, 200 AH). The USA made solar pump was 0.5 hp suitable for surface water lifting, Australia made submersible solar pump was same capacity but suitable for surface and ground water lifting, and China made pump was 2.2 hp motor capacities also suitable for both surface and groundwater lifting.

Among the five tested solar pumps, China made solar pump (Lorentz, PS 1200, Germany) was found technically suitable for both surface and ground water lifting. Three China made submersible solar pumps each of 1000 W solar panel capacity were installed in Gazipur, Jamalpur and Magura for groundwater irrigation. One solar pump of same panel capacity and model was installed in Barisal for surface water irrigation. In Gazipur, the solar pump was used for drip and furrow irrigations for tomato cultivation and in Jamalpur it was used for brinjal cultivation during the rabi season of 2011-2012. In Barisal and Magura solar pumps were used for boro rice cultivation during 2011-2012.

Table 1. Specifications, performance and costs of different types of solar pumps

Specification /features	BARI designed	DU designed	USA made	Australia made	China made
Suitability for lifting	Surface water	Surface water	Surface water	Ground water	Ground water
Pipe diameter (mm)	38 (1.5")	25 (1.0")	38 (1.5")	25 (1.0")	38 (1.5")
Motor type	dc	ac	dc	dc	dc
Total panel power (W)	600	675	600	600	1050
Discharge (l/min)	60	34	100	90	120
Total cost of solar pump	85,000	1,42,500	2,10,000	2,10,000	3,05,000

Operation of solar pump in Gazipur

Operation of solar pump in Jamalpur

Results/Outputs

The survey results showed that earlier (before 2010) the most of the solar pump users were indigenous people of the North Bengal and they were supplied drinking water almost free of cost by different NGOs. At present (2012) there are about 150 different types of solar pumps using in different locations of Bangladesh and about 50 solar pimps are using for irrigation. The size (power) of the solar pumps ranging from 0.50 hp to 10 hp. Panel cost was the major cost (45%) of solar pump followed by installation cost (18%), motor cost (16%) and pump cost (10%). Pipes and fitting cost was the lowest (4%) among the cost components (Fig. 1).

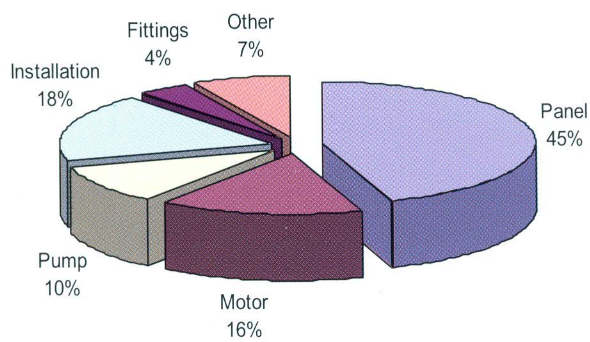

Fig. 1. Percentage of cost component for installation of solar pump

The life of solar panel is about 25 years and pump life is 10 years. For 4 hp capacity, the initial costs (price of pump set, installation, fittings etc.) of diesel and PV operated pumps are about Taka 40,000 and Taka 600,000, respectively. Operation cost of solar pump is very low but it is higher for diesel pump due to diesel and oil costs including repair and maintenance cost. After 20 years the cumulative costs of diesel and PV operated pump become Taka 1308200 and Taka 900000. It is shown in Fig. 2 that cumulative cost of diesel operated pump is lower than solar pump up to 14 years and then (after 14 years or more) solar pump becomes more economic. But solar pump is non-pollutant and environment friendly irrigation technology.

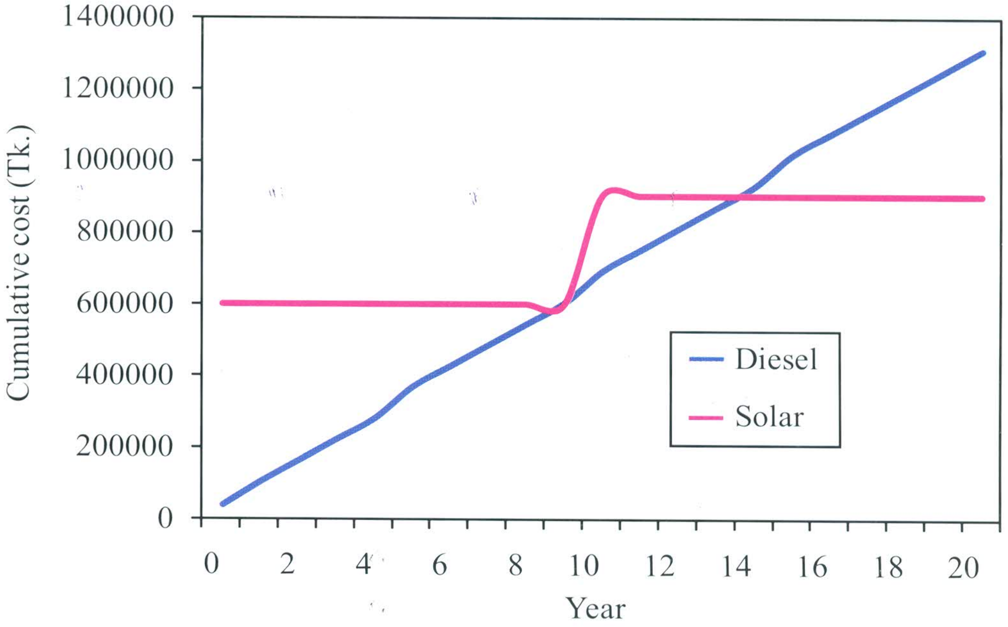

Fig. 2. Cumulative costs of diesel and solar PV operated pumps

Experience in rice and vegetable cultivation

The water requirement of boro rice (BRRI dhan 28) in Barisal was 1481 mm and in Magura for Kazol Lota rice was 1024 mm. The average water requirement for boro rice was 1253 mm and command area was 0.75 ha. Water requirement per season in drip method for tomato cultivation was 254 mm and furrow irrigation method was 590 mm. Yield of drip irrigated tomato was significantly higher than that of furrow irrigated tomato. Water saving in drip irrigation over furrow irrigation for tomato cultivation was 57%. For brinjal cultivation, the depth of water applied in drip and furrow irrigation during the season was 453 and 228 mm, respectively. Hence the water saving by drip irrigation over furrow irrigation for brinjal was about 50%. There was no significant difference of yield between drip and furrow irrigated brinjal.

Solar irrigated rice field in Barisal

Solar irrigated tomato field in Gazipur

Economic benefit

The estimated command areas for tomato in drip and furrow irrigation methods were 2.60 and 1.75 ha and for brinjal were 2.80 and 1.85 ha, respectively (Table 2). For boro rice cultivation, the irrigation coverage (command area) was 0.75 ha. Both gross and net returns obtained by drip irrigation were higher than furrow irrigation for both tomato and brinjal. The benefit cost ratio (BCR) of drip irrigation was higher than furrow irrigation. Tomato cultivation by solar pump is more economic than brinjal. Vegetable cultivation by solar pump irrigation was found economically viable. But, boro rice irrigation by solar pump is not economically viable (BCR 0.18) due to high water demand and low yield.

Table 2. Economic analysis of solar pump irrigation for rice and vegetables

Cost items	Tomato		Brinjal		Boro rice
Initial investment (Taka)	500000		500000		500000
Fixed cost	140000		140000		140000
Irrigation method	Drip	Furrow	Drip	Furrow	Flood
Water requirement (mm)	254	590	228	453	1253
Command area (ha)	2.60	1.75	2.80	1.85	0.75
Variable cost (Taka/year)	322200	178480	348277	209250	87750
Total cost (Taka/year)	462200	318480	488277	349250	227750
Total production of crop (ton)	163.67	93.66	76.41	47.76	2.75
Farm gate price (Taka/ton)	12000	12000	15000	15000	15000
Gross return (Taka/year)	1964040	1123920	1146180	716505	41287
Net return (Taka/year)	1501840	805440	657903	367255	-186463
Benefit cost ratio (BCR)	4.25	3.52	2.35	2.05	0.18

Note: Total investment = price of solar pump + solar panel + pipes, fittings, etc. Life of solar pump = 15 years.

Achievements

- Panel cost is the major cost (45%) of solar pump
- Solar pump is found technically suitable for both surface and ground water lifting
- BARI centrifugal type solar pump is suitable for surface water irrigation
- China made (Lorentz 1200 PS) solar pump is suitable for both surface and groundwater lifting
- Drip irrigation in vegetables saves about 50% water than furrow irrigation method
- Vegetables cultivation by solar pump irrigation is economically profitable
- Rice cultivation by solar pump irrigation is not found economically viable
- Cumulative cost of 4 hp diesel operated pump is lower than solar pump up to 14 years and then (after 14 years or more) solar pump becomes economic.

Way towards wider use of solar irrigation

- Subsidy may be provided on solar irrigation pump as providing on diesel, electricity etc.
- Awareness should be created to the farm people through different mass media about the uses of pollution free solar irrigation pump
- Local manufacturers may be encouraged through soft loan or incentive for manufacturing solar panel and solar pump locally so that cost of solar pump may be reduced.

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